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A Strategic Evaluation of Energy-Consumption and Total Execution Time for Cloud Computing Environment

Souvik Pal[1], Suneeta Mohanty[2], Prasant Kumar Pattnaik[3], G.B.Mund[4]
Email: souvikpal22@gmail.com
[1,2,3,4]KIIT University, Bhubaneswar, India
Email: {smohantyfcs@kiit.ac.in, patnaikprasantfcs@kiit.ac.in, mund@kiit.ac.in}

***Abstract*: Cloud computing is a very budding area in the research field and as well as in the IT enterprises. Cloud Computing is basically on-demand network access to a collection of physical resources which can be provisioned according to the need of cloud user under the supervision of Cloud Service provider interaction. In this era of rapid usage of Internet all over the world, Cloud computing has become the center of Internet-oriented business place. For enterprises, cloud computing is the worthy of consideration and they try to build business systems with minimal costs, higher profits and more choice; for large-scale industry, energy consumption and total execution tome are the two important aspects of cloud computing. In the current scenario, IT Enterprises are trying to minimize the energy-consumption which, in turn, maximizes the profit of the industry. And they are also trying to reduce total execution time which, in turn, is concerned with providing better Quality of Service (QoS). Therefore, in this paper we have made an attempt to evaluate energy-consumption and total execution time using CloudSim simulator which helps to make evaluation performance of energy consumption and total execution time of user application.**

***Index Terms*: Cloud Computing, Virtualization, Cloudlet, CloudSim.**

I. Introduction

cloud computing or Internet computing is used for enabling conve-nient, on-demand network access to a networks, servers, mass storage and application specific services with minimal effort to both service provider and end user [1]. In a simple way we can say that a Cloud itself an infrastructure or framework that comprises a pool of physical computing resources i.e. a set of hardware, processors, memory, storage, networks and bandwidth, which can be organized on Demand into services that can grow or shrink in real-time scenario [2][3]. In a cloud computing environment, there is a set of interconnected and virtualized resources being dynamically provisioned according to the need of the user and depending on the Service-Level-Agreement (SLA) service [4]. In this era of immense usage of internet throughout the globe, virtualization technology is the key feature of Cloud Computing. Virtualization technology creates an environment that enables on-demand and convenient network access to a shared collection of configurable physical resources (i.e. set of hardware, processors, memory, storage and bandwidth) and as well as helps the creation of individual Virtual Machines (VM) according to the need of the cloud user.

In this era of rapidly growing usage of internet throughout the world, Cloud Computing has become the icon of Internet-centric business place in the IT industry. The Cloud Computing is not a totally new technology; it is basically a journey through distributed, cluster and grid computing. In compared to cluster and grid computing, clouds are highly scalable, capable of both centralized & distributed resource handling, loosely coupled and provide on-demand computation & application service. Cloud computing is basically known as computing over internet. Cloud computing is an enhancement of distributed and parallel computing, Cluster Computing and Grid computing. In this advanced era, not only user able to use a particular web based application but also that may be in active participation in its computational procedure by either adopting ,demanding or pay-per-use basis [9][10].

In this era of immense usage of internet throughout the globe, the main aim of the major cloud service providers is maximum usage of the resources with minimal waiting time. Therefore, we have presented in this paper a strategic approach of evaluating energy-consumption and total execution time for cloud computing environment.

A. Need for Virtualization

A virtualization environment that delivers applications as services over the Internet and also provides services that involve hardware and system software in the data centers [5], which is the key features of cloud computing. Virtualization is used computer resources to imitate other computer resources or whole computers [6] [8]. Virtualization provides a platform with complex IT resources in a scalable manner (efficiently growing), which is ideal for delivering services. At a fundamental level, virtualization technology enables the abstraction or decoupling of the application payload from the underlying physical resources [4]; the Physical resources can be changed or transformed into virtual or logical resources on-demand which is sometimes known as Provisioning. However, in traditional approach, there are mixed hardware environment, multiple management tools, frequent application patching and updating, complex workloads and

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multiple software architecture [8]. But comparatively in cloud data center far better approach like homogeneous environment, standardize management tools, minimal application patching and updating, simple workloads and single standard software architecture [7].

The paper organized as follows:

In the section II, we have discussed a mapping approach from host machine to Virtual machine. Section III has given the idea of simulation workflow. And in the section IV, we have given our test & experimental results. And lastly Section V concludes the work.

II. A Mapping Approach

In this paper, we will discuss a mapping approach of Virtual Machines onto host machines depending on the availability of the distributed resources [11] [6].

We have defined our system as S where the set of Virtual machines (V) are to be mapped onto the set of physical host machines (H); and pool of physical resources are denoted by P.

P = {CPU cores, Memory, Storage, I/O, Bandwidth, Networking}.

According to the user-needs like IT infrastructure, platform service or software usage, VM instances are created by the hypervisor administrator who controls the mapping of VMs.

We have considered VS as Virtual Machine set:

$VS = V_1 + V_2 + \dots + V_m = \sum V_i$

$V_i = \{ vc, vm, vr\}$

Where

vc = Number of CPU Cores

vm = Main Memory

vr = Storage Capacity

m = Number of Virtual Machines

Now we considered HS as a Set of host machines:

$HS = H_1 + H_2 + \dots + H_n = \sum H_i$

$H_i = \{hc, hm, hr\}$

Where

hc = Number of CPU Core

hm = Main Memory

hr = Storage Capacity

n = Number of host machines.

Now we divide the host set into two subsets:

$HS = HS_a + HS_b$ (a + b = n).

Where

HS_a = Set of physical machines having available resources to host VMs and on which VMs can be mapped.

HS_b = Set of remaining physical machines not having enough resources to host VMs and on which VMs cannot be mapped.

Let $f{:}V_i \rightarrow HS_a$ be the Function which maps VM instance to the set of physical machines having enough resources to host the VM. There may be either one to one mapping or many to one mapping. In one to one mapping, one VM instance may be mapped onto one host machine and in many to one mapping, many VM instances may be mapped onto one host machine. Function f: $V_i \rightarrow H_i$ describes the one to one mapping and function f: $\sum V_i \rightarrow H_i$ maps many to one mapping from the host set HS_a based on the requirements and workload of the use. In this way, VM instances may be mapped onto host machine.

III. Simulation Workflow

In this section, we have briefly discussed our simulation work-flow.

STEP 1: Cloud subscriber allocates the tasks to the cloud broker.

STEP 2: Cloud Broker partitions the assigned task into same-sized segments which is cloudlets. Cloudlets models the cloud-based application services and it encapsulates the number of instructions to be executed, amount of disk transfer to compute the task [14] [15].

STEP 3: Cloud Broker sends the newly created cloudlets to the Virtual Machine Manager (VMM).

STEP 4: Each datacenter entity will make the registry with the Cloud Information Service (CIS) so that the cloud broker will get all the information about the datacenters.

STEP 5: While user-request has came, cloud broker consults with the CIS registry to get the list of cloud providers which is capable of offer the required infrastructure that meets application's QoS, software and hardware requirements.

STEP 6: From the CIS, the cloud broker gets all the information about the datacenter and checks which datacenter is available for handling the user-request.

STEP 7: VMM creates the Virtual machine.

STEP 8: Data center entity invokes a method for every host, updateVmProcessing(), which manages the processing of task units that is handled by the respective VMs; therefore, all the processes are continuously being updated and monitored.

STEP 9: At the host site, invocation of updateVmProcessing() triggers a method called updateCloudletProcessing() which directs every VMs to update their respective task unit status with the datacenter entry, including executing, suspend and finish operation.

STEP 10: After that VMs return the next probable completion time of the task units which are currently deal with by them.

STEP 11: The minimum completion time among all the computed data is being sent to the datacenter entity.

STEP 12: Execution-request of the cloudlet is sent by the VMM to the virtual machine.

STEP 13: The VM sends the respective cloudlets to the VMM, which has been executed.

STEP 14: After that VMM sends the executed cloudlets to the cloud broker.

STEP 15: Cloud Broker then combines all the executed segments or cloudlets together to reform the task again.

STEP 16: At the final stage, the executed task is being sent back to the user by the cloud broker.

IV. Test and Evaluation

In this section, we are going to present test and evaluation that is involved in Total execution time which in turn meets the Quality of Service (QoS) of the Cloud Service Provider and energy-consumption which is concerned to

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energy-efficiency while using different VM Allocation policy and single VM Selection Policy. The tests were conducted on a 32-bit Intel Core i5 machine having 2.60 GHz and 3 GB RAM running windows 7 Professional and JDK 1.6. The main goal of our tests is to make a comparison concerned with Total execution time and energy consumption while varying the number of VMs with different VM Allocation policies.

We have used Eclipse Java EE IDE for Web Developers, Version: Juno Service Release 2 and CloudSim version 3.0 for simulation purpose. In our experimental set up, this simulation creates a heterogeneous power aware data center which applies VM allocation and VM Selection policies. And also subject to other constraints this Simulation is done.

The simulation environment consists of two types of hosts which are modeled as HP Proliant ML110 G4 Xeon 3040 machine having 1.86 GHz processor (1860 MIPS), Dual core and HP Proliant ML110 G5 Xeon 3075 machine having 2.66 GHz processor (2660 MIPS), dual core. Both host machines have been modeled to have 4 GB of RAM, 1 TB of Storage. In this simulation, we are using four types of VMs; each of VM having 2500, 2000, 1000 and 500 MIPS and 870, 1740, 1740, and 613 MB of RAM respectively. All VM types have single core and 2.5 GB of VM size. In this simulation, the datacenter is created, which has the characteristics like x86 of architecture, Linux as operating system, Xen as VMM.

We have considered three types of VM Allocation policy for simulation point of view: Inter Quartile Range (Iqr), Median Absolute Deviation (Mad), and Static Threshold (Thr) [12][13], and Minimum Migration Time (Mmt) as VM Selection policy [12][13]. We have compared each VM Allocation policy with Minimum Migration Time while changing the numbers of VMs.

Here we present our simulation work where we are varying the numbers of VMs from 10 to 100 and we have calculated the energy consumption (in KWh) while considering three cases like IqrMmt, MadMmt, and ThrMmt. In the third case, where we have used Static Threshold as VM allocation policy and Minimum Migration Time as VM selection policy, the energy consumption is less than other two cases as shown in the figure [1].

In the next figure [2], we want to present our another simulation for calculating total execution time, where we have

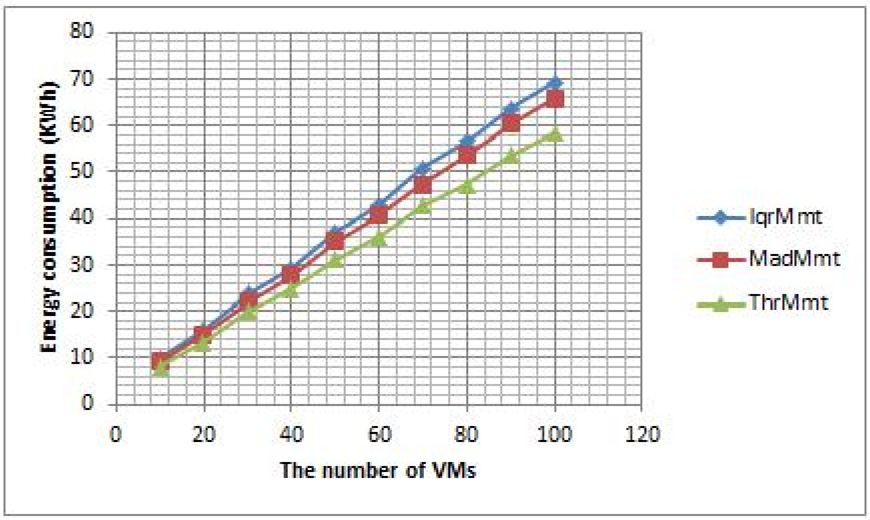

Figure 1: Experiment Results-Total Energy Consumption by the system

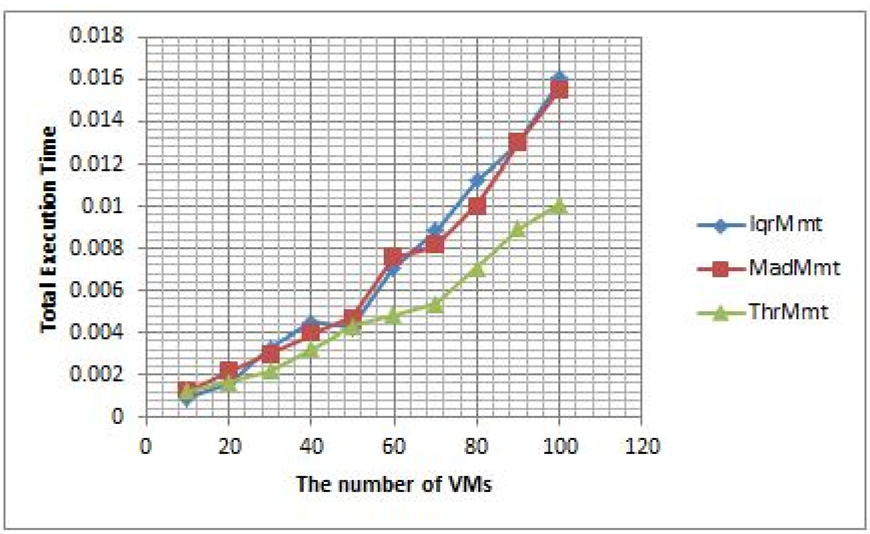

Figure 2: Experiment Results-Total Execution Time By the System

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considered the same three situations as stated above and here also we can say that if we use Static Threshold as VM allocation policy and Minimum Migration Time as VM selection policy, the total execution time is much more less than the other two situations.

V. Conclusion and Future Work

Rapid usage of Internet over the globe, Cloud Computing has placed itself in every field of IT industry. The recent efforts to make cloud computing technologies better, which includes energy consumption and total executing time, we have focused on those particular facts in this paper. Therefore, we have concentrated on simulation-based approaches which help the cloud developers to test performance which is concerned with energy consumption and total execution time. In this paper we have discussed different VM selection policy and also different VM allocation policy and also have made a comparison with the variance of number of Virtual Machines. At the end of our work, we can conclude that our step-wise simulation-workflow and our test & simulation results may help to develop in cloud infrastructure in this rapid usage of Internet among the people. Some other aspects like evaluating CPU Debt, different core configuration, different service policies, and also VM migrations in different simulation environment are left as the future work.

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